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Education in the Digital Age: Technological Trends in Anatomy Education

Dijital Çağda Eğitim: Anatomi Eğitiminde Teknolojik Eğilimler

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Abstract

New developments in medicine and health sciences produced high volume knowledge. However, the more knowledge led to narrowing in duration of anatomy education given to students. For this reason, it may be useful for teachers who teach anatomy to use alternative learning strategies and alternative educational tools, including today's interactive digital technologies, to enhance the effectiveness of anatomy teaching. This research is a literature review study. In order to reveal the current situation and to make it better understandable, the research is based on the review of the literature. In this study, it is observed that use of interactive digital technologies in anatomy education is insufficient and no so widespread. Therefore, the aim of this study is to reveal the significance of interactive digital technologies that can be used in anatomy education. In accordance with this aim, the study mentioned about some important digital technologies and teaching strategies such as flipped classroom model and gamification in anatomy education. Indeed, the development of digital technologies has not only created an impact on electronics, space science, agriculture and medicine, but also on education. Nowadays, students can learn anatomical tissues through 3-dimensional digital cadavers, they can access them and repeat study whenever and wherever they want. These new learning materials in digital age encourage each student to use their time more effectively in accordance with their own

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learning pace and skill set. It is expected that this study will contribute to the anatomy teachers on improvement of learning environments and using interactive digital technologies in anatomy education.

Keywords: *anatomy education, flipped classroom, gamification, infographics, digital technologies*

Öz

Tıp ve sağlık bilimlerindeki yeni gelişmeler, daha hızlı ve daha çok bilgi üretilmesine olanak sağlamıştır. Ancak üretilen bilginin artması, öğrencilere verilen Anatomi eğitiminin süresinde bir daralmaya yol açmıştır. Bu nedenle, Anatomi dersi veren öğretmenlerin, günümüzün yenilikçi dijital teknolojileri, alternatif öğrenme stratejileri ve alternatif eğitim araçlarını kullanmaları, anatomi öğretiminde etkinliği arttırma konusunda faydalı olabilir. Bu araştırma, Anatomi eğitiminin verildiği öğrenme ortamında kullanılabilecek interaktif dijital teknolojilere odaklanmak ve mevcut durumu daha anlaşılır hale getirmek için yapılan bir literatür incelemesidir. İncelemelerle elde edilen veriler araştırmacılar tarafından betimsel yaklaşımına uygun olarak değerlendirilmiş ve yorumlanmıştır. Yapılan çalışmalar incelendiğinde, Anatomi eğitiminde interaktif dijital teknolojilerin kullanımının yeterli ve yaygın olmadığı anlaşılmaktadır. Bu nedenle, bu çalışmanın amacı, Anatomi eğitiminde kullanılabilecek interaktif dijital teknolojilerin ve bu teknolojilerle beraber kullanılabilecek öğrenme/öğretme stratejilerin de neler olabileceği hakkında bilgi vermek ve bunların önemini ortaya koymaktır.

Dijital teknolojilerin gelişmesi sadece sanayide, elektronikte, uzay bilimlerinde, tarımda veya tıp alanında değil aynı zamanda eğitimde de önemli etkiler yaratmıştır. Günümüzde dijital teknoloji, yeni verilerin oluşturulmasında ve bu verilerin yeni öğretim platformlarına aktarılmasında çeşitli olanaklar sağlamaktadır. Dijital teknolojinin etkisiyle, yüzlerce yıldır konservatif bir yapıda devam eden anatomi eğitiminin sınıf içi teorik derslerin yapısı pek değişmemiştir. Üstelik kadavra diseksiyonu üzerinden verilen uygulama eğitimi sorgulanmaya başlanmıştır. Bu durum anatomi eğitiminde ciddi bir dönüşümün öncü göstergesi olarak kabul edilebilir. Günümüzde dijital eğitim materyallerinin öğrenci ile etkileşim kurabiliyor (interaktif) hale gelmesi, bu dönüşümün en önemli tetikleyicisidir. Bazı çalışmalar göstermektedir ki öğrenciler, anatomik dokularla ilgili öğrenimlerini 3-boyutlu (3D) dijital kadavralar üzerinden yapabilmekte, bu ders materyallerine istedikleri zamanda, istedikleri yerden ulaşabiliyor ve istedikleri kadar tekrar yapabilmektedirler. Dijital çağın sunduğu bu yeni öğrenme materyalleri, her öğrenciyi kendi öğrenme hızına ve becerisine uygun biçimde zamanı daha etkin kullanmaya teşvik etmektedir. Ayrıca, öğrenme etkinliğini arttırmak için ters-yüz sınıf modelinin bir öğretme stratejisi olarak kullanılması; Kahoot, Classcraft, Plickers, Padlet gibi oyunlaştırma yöntemlerinin geliştirilmesi; infografiklerin kullanılması; mobil öğrenme araçlarının ve bunlara

ait programların da bu öğrenme ortamlarına entegre edilmesi ile dijital teknolojilerin eğitim alanına çok ciddi bir katkı sunma potansiyeli olduğunu göstermektedir.

Sonuç olarak, bilginin daha iyi işlenmesini sağlayan, eğitimde zamanı ve mekanı daha etkin kullanmamızı mümkün kılan dijital çağın bu yeni ürünleri, günümüzde, emekleme safhasında olan arttırılmış gerçeklik, sanal gerçeklik, Web 4.0 ve yapay zeka gibi araçların da entegre edilmesiyle, eğitimde zamanı daha etkin kullanan, daha eşitlikçi eğitim ortamı, daha objektif ölçme ve değerlendirme yapabilme olanağı sağlayan yeni öğrenim platformları sunmaktadır. Bu çalışmanın, Anatomi öğretmenlerine, öğrenme ortamlarının iyileştirilmesine ve Anatomi eğitiminde etkileşimli dijital teknolojilerin kullanılmasına katkı sağlaması beklenmektedir. Bu çalışma ile Anatomi öğretmenlerinin, 3D dijital Anatomi materyalleri ve dijital Anatomi kaynaklarını dijital teknolojiler kullanarak geliştirmeleri ve bunları ters-yüz sınıf, oyunlaştırma gibi dijital teknolojilere dayalı öğrenme stratejileri ile entegre ederek zenginleştirilmiş öğrenme ortamları geliştirmelerine ve bu geliştirilen interaktif dijital teknoloji destekli Anatomi eğitimi sağlanan ortamları eğitim sistemimize kazandırmalarına yardımcı olacağı ümit edilmektedir.

Anahtar sözcükler: *anatomi eğitimi, ters-yüz sınıf, oyunlaştırma, infografik, dijital teknolojiler.*

Introduction

Since the introduction of computers in the 1950s, technology has had important and beneficial effects in terms of the supply of goods and services, the analysis of meteorological and geological conditions as well as forecasting (e.g., earthquakes, weather, global warming) (Flyn, 2002). In addition to producing this institutional information, computers have also begun to be used for daily life operations in human life and are increasingly influential. In fact, it is not wrong to say that people are becoming increasingly addicted to computers. This is the case in all areas of life and the relationship between digital technology and humans is being reshaped every day. Of course, human beings interacting with new technologies in the digital age are inevitably benefiting from these technologies and possibilities in educational settings. However, Larry Cuban has argued that computers do not play an important role in teaching practices, based on their work (Cuban, 1986; Cuban, 2000; Cuban, 2001). In the mid-1980s, Cuban was probably right, but this claim was seriously questioned in 2000, (Becker, 2000). Becker and Ravitz showed that Cuban's claims were invalid (Becker & Ravitz, 2001). In

developed countries, after the personal computer revolution, computers began to spread rapidly in the 1970s and began to be used in houses and schools (Fidalgo-Neto et al., 2009). Computers play many important roles in modern teaching laboratories, such as the delivery of pre-laboratory courses to students, interactive exams, molecular modelling and theoretical calculations, animations, data collection and analysis (Kennepohl, 2001). Indeed, when recent decades are examined, it can be seen that computers are located at almost all levels of educational institutions and computer laboratories are now established in schools (Grieshaber, 2010). It can also be seen that the course materials presented to the students are becoming increasingly digital, that the assignments and evaluations given to the students are being given on digital platforms (Terzis & Economides, 2011), and that even in the curriculum, the students are provided with courses aimed at developing computer programs (Zyda, 2009; Repenning, 2012; Denner, Werner, Ortiz, 2012), or developing computer game software or robotics software (Coxon et al., 2018; Yilmaz, et al., 2013; Bers, et al., 2014; Costa, 2017; Bartholomew & Furse, 2015).

Today, learning by utilizing digital technologies and accessibility to information by means of education are at high levels. Nevertheless, some studies have shown that access to computers in class is not sufficient to ensure student participation and to increase the effectiveness of the teacher. (Warschauer, Cotten & Ames, 2011). In fact, it can be seen that teachers, who are important users of digital technologies besides the students in schools, are increasingly adapting themselves to the new situation and are contributing to this transformation. However, it may take some time to understand how these technologies are used and to see their effects. Teachers are still playing an important role in all educational processes during this significant transformation. In this respect, the dominant role of the teachers will continue to provide solutions during the education processes. In doing this, it is inevitable that teachers should have technological literacy and that they use digital technologies effectively, which will contribute to their teaching success. Until recently, teachers had focused on the mechanical use of these devices, but it can now be seen that the pedagogical use of computers, learning, and teaching methods is also important for them (Valanides & Angeli, 2008).

From a historical point of view, some of the digital technological developments used in education are very important. For example, the establishment of Microsoft in 1975, the first trial of the computer-based behavioral teaching model in 1976 in the United States and in England, the establishment of Apple in 1977, Microsoft's first text processing system,

"Microsoft Word", in 1983, the introduction of Microsoft's "Windows operating system" to the market in 1985, the release of the first e-book reader was on the iPhone in 2007 (Zawacki-Richter & Latchem, 2018), the establishment of the first massive open online courses (MOOCs) in 2008 (Bozkurt, Keskin & de Waard, 2016), followed by other developments such as the launch of the iPad's in 2010, are all key technological developments that have rapidly increased the effectiveness and prevalence of online and mobile learning platforms. Indeed, students are now entering classrooms with their laptops, tablets and smartphones (Brown & Pettito, 2003). Of course, while students bring these digital technologies to school, their sole purpose is not to take notes while they are listening to lessons (Fried, 2008). This has led to the initiation of new debates concerning the claim that schools and classes are becoming computer environments (Brown & Pettito, 2003; Wurst et al., 2008; Kraushaar & Novak, 2010). The debate has focused on the question of whether these technologies are harmful or beneficial to learners. There have been reports in studies showing that the use of these technologies in non-structured classes has reduced student achievement, and it has been reported that the use of these technologies should be limited in classes (Fried, 2008). However, another study did not find a significant difference in terms of Grade Point Average (GPA) scores between the students who brought these technologies to class and those who did not (Wurst et al., 2008). Today, it is becoming increasingly possible to transfer the course subjects to the students by taking advantage of the digital technologies that have been used in classes, particularly in anatomy classes, which is considered to be difficult course in health sciences education and in medicine, incorporating many Latin terms. This allows the students to take advantage of the opportunities of the digital age, thereby creating a more effective learning environment (Groff, 2013; Dede, 2014).

1. The problem statement

Because of new developments and produced much more knowledge in medicine and health sciences, the duration of anatomy education given to students is narrowing in the curriculum. Therefore, anatomy lecturers have to use alternative learning strategies and alternative education tools including today's innovative digital technologies. The question of "What are these digital technologies?" constitutes the main problem of this research and below questions were sought in this context:

- What main digital technologies can be used in anatomy education?
- What main learning strategies benefiting from digital technologies can be used in anatomy education?

2. Aim of the study

We see that the digital technologies developed today are used as a teaching tool in many different areas and these technologies are being used with different learning strategies (Ferrer-Torregrosa et al., 2016; Ang et al., 2018; Singh & Min, 2017). The main aim of the study is to reveal the significance of digital technologies that can be used in anatomy teaching. In accordance with this aim, the study mentioned about some important digital technologies in teaching and learning anatomy. Also, flipped learning/classroom and gamification subjects were mentioned in the study as learning strategies that can enhance the effectiveness of anatomy teaching.

3. Methodology

This study focuses on how digital technologies and learning strategies can be used effectively in anatomy education. For this purpose, anatomy education studies in the literature have been reviewed. Therefore, this study is based on a literature review research method. The aim of a literature review can be expressed as obtaining information needed for a research topic before developing an argument (Arshed & Danson, 2015). The articles, which are suitable for the purpose of the study, in the literature obtained from the Web of Science and PUBMED databases are the sources of this research.

The issues of digital technologies, which can be used in anatomy education and the advantages of them, will be discussed while examining the articles for this study. Therefore, the studies mentioning technology-based learning environment that can be used in anatomy education, computer-based education, internet-based education, mobile learning-based education, massive open online courses (MOOCs), infographics, 3-dimensional digital anatomy materials, augmented reality, virtual reality, wearable technologies, flipped classroom model and gamification have been analyzed and interpreted in accordance with the scope of this research.

4. Results

When the studies obtained by the literature review are examined, it is seen that almost all of these studies are focused on a single subject related to digital technologies, which are effective and available for anatomy education (Brazina, Fojtik, Rombova, 2014; McMenamin, et al., 2014; Custer & Michael, 2015; Ozdamli et al., 2016; Estai & Bunt, 2016; Balogun, 2018). However, it is seen that there are only a limited number of studies covering the general digital technologies available for anatomy teaching.

As a result of this study, it has been seen that the developments in digital technologies strongly support the creation of technology-based learning environments. It is also evident that today we have some digital technologies that can be used effectively in the future anatomy education. Some of these digital technologies are; MOOCs infographics, 3-D digital simulation programs, augmented reality, virtual reality and wearable technologies. With the development of digital technologies, new learning strategies have also been developed such as Flipped classroom and gamification.

4.1. Technology-based learning environments

By the emergence of the microcomputer in the 1980s, the potential of this new information technology was seen as a lever to improve the quality of education and this development has created high expectations (De Corte, 1994). Indeed rapid developments in digital technology resulted in new teaching techniques and platforms. Today there are many technologies produced during the digital age that are being used in the teaching of anatomy. However, the discussion surrounding these technologies is beyond the scope of this study. Nevertheless, some digital technologies that are thought to be important will be mentioned, such as personal computers, internet, mobile smart devices contributed to anatomy education as well. In addition to these developments some other digital technologies arose such as massive-open-online-courses (MOOCs), infographics, digital 3D simulations, augmented reality (AR), virtual reality (VR), and wearable technologies.

4.1.1. Computers and computer-based learning in anatomy education

With personal computers becoming more widespread, computer-assisted education in the education field has always been on the agenda. Computers have come to the fore as powerful and realistic education tools, not only in developed countries, but also in developing and underdeveloped countries (Kozma & Anderson, 2002). Anatomy is considered as one of the fundamental courses in medical and health sciences education and clinicians begin to develop their clinical skills through this course. In the mid-nineteenth century, it was possible to obtain a doctor's degree diploma in the United States, even though education on human dissection was not given significant focus. However, many medical educators have argued that disciplined medical students should form a practical basis for possible surgical procedures in general practice. This understanding has led to dissection gaining increased prominence for medical students (Warner & Lawrence, 2006). For safe clinical practices, and for surgical disciplines in particular, it is important that anatomy must be well understood (Turney, 2007). The use of cadavers is the most important component of anatomy education, and the usage of the anatomy

models prepared with special digital software is becoming more prominent because of the limited accessibility of human cadavers (Hoyek et al., 2014). Since the anatomy learning process is based on diagrams and anatomical images in particular, it is very convenient for computers to be used for anatomy training. Thus, it is more interesting for the student if the course is presented with multimedia tools via computer (Ur-Rehman et al., 2012). Computers enable the instructor to create a good organizational structure in the intended form before giving lectures to the students (Cassady, 1998). Indeed, computers for students and instructors are advantageous in terms of both time and cost. At the same time, computers provide students with the possibility of viewing magnetic resonance (MR) and x-ray images to the students together (Ur-Rehman et al., 2012). Computer-assisted learning can be very useful in anatomy training if it is well-designed and the curriculum is well integrated (Tam et al., 2009).

4.1.2. Internet-based learning in anatomy education

There are some difficulties in anatomy training due to the increase in the number of students taking anatomy courses and compulsory application hours. Due to the limited use of laboratories and the limited number of teaching staff, small groups of students cannot be taught anatomy lessons (Ozer et al., 2017). However, educators are now developing new strategies. The development of video streaming and broadcasting technology, the development of web-based computer-assisted learning platforms such as Moodle and Blackboard, and the ability to combine varied communication and information technologies facilitate the integrating students as part of the learning process (Saxena et al., 2008). In general, web-based visual courses are useful in teaching anatomy with internet-based learning (IBL) because it produces solutions that are tailored to the intellectual and psychological profiles and needs of each student. Furthermore, IBL can contribute to the success of the learner, particularly in large groups (Ozer et al., 2017). Providing e-learning items through learning management systems (LMS) is one of the key factors for effective and permanent learning in medical education (Gray & Tobin, 2010).

4.1.3. Mobile devices and mobile-based learning in anatomy education

Shortly after tablet computers were introduced, they quickly found application fields in many countries. Since the use of mobile devices has increased many scientists are interested in using these technologies in education and in classroom in the belief that students will benefit from these mobile technologies. As a result, tablet computers have been used for anatomy courses. For instance, Lynn et al. (2015) reported that mobile devices contributed positively to students' learning experience, that students increased their cooperation with their peers, and

that these mobile devices helped them to learn course subjects by using anatomy of muscle and skeletal systems that were loaded on iPad computers. Smartphones are the most common mobile devices which are becoming increasingly popular in both personal and professional arenas. Over the last decade, we have seen the introduction of new technology that has changed many aspects of our culture, our business, our communications, and our education. Smartphones have been rapidly adopted in many countries, and information is now easily accessible in ways that were not possible before (Gavali et al., 2017). Smartphones are considered to be a suitable tool for providing further education for many reasons, particularly in developing countries. It is generally acknowledged that this is because mobile phones are more common and their penetration rate is higher in developing countries. Nevertheless, the growing impact of mobile phones on the educational environment in developing countries needs to be investigated based on evidence (Walk et al., 2010). Nowadays, smartphones are being used in many fields of medicine. Moreover, the number of applications and programs developed for use in medicine is increasing day by day. As an educational tool, the smartphone has the capacity to provide both the theory and the application of the desired information. There are some studies showing that smartphones are a useful educational tool for medical students (Robinson et al., 2013; Jamali et al., 2015; Wenting et al., 2017; Mackay, Anderson & Harding, 2017; Risling, 2017).

4.1.4. MOOCs (massive open online courses) in anatomy education

MOOCs are *massive* courses where thousands of learners can enroll on the same course. MOOCs are *online* platforms that are open to everybody and are created by higher education institutions around the world that provide open access to anyone on a commercial platform such as FutureLearn, EdX or Coursera. MOOCs have been criticized for the limited pedagogical nature of the video lessons that only have multiple-choice exam questions. When assessed in terms of the medical curriculum, it is thought that MOOCs are currently unable to integrate the curriculum and provide a real advantage over open educational resources (Doherty et al., 2015). Although there are many studies about medical education through MOOCs in the literature, the potential role of MOOCs has not yet been sufficiently explored (Pickering et al., 2017).

4.1.5. Infographics in anatomy education

Visualization ensures that complex information in the learning process is given to students in an easier and more effective way. Infographics, which is a visual medium, is being increasingly used as a means of communication. As human beings, we have more interest in the visuals, and the visual expressions and narratives drawn graphically attract us easily. It is

undeniable that people are bombarded with more information on a daily basis than was the case 20-30 years ago (Evans, 2016). Every day, we encounter vast amounts of new information coming from new situations, social media tools, radio and television, e-mail, advertisements, billboards, daily work at the office, and various other sources. In fact, the reality is that the amount of information we process is limited. As a result, infographics with images, texts and numbers attract our attention more effectively and more easily than information attacks coming from other sources. Based on these positive features, studies on how to exploit the advantages of infographics in education have been investigated (Ozdamli & Ozdal, 2018). Infographics facilitate the process of transferring and understanding complex and very large amounts of information. In particular, infographics highlight important texts and data which could be missed by the reader in long texts. In this respect, the fields of use of infographics are growing rapidly, not only in social media, but also in academic platforms. Ozdamli et al. (2016), investigated perceptions and views of the students relating to the anatomy course presented to them with infographic materials. More than half of the students 58.6% thought that taking an anatomy course with infographics was beneficial for them learning the subject. More significantly, 86.4 % of the students reported that they had a better understanding of the lessons with infographics.

4.1.6. Three-dimensional digital simulations/programs in anatomy education

Traditional methods commonly used in anatomy teaching include in-class courses, text books, atlases, and if available, cadaveric dissection. In anatomy education, cadaveric dissection is significantly important. It is thought that cadaveric dissection provides students with manual dexterity and communication skills (Aziz et al., 2002). However, the reality is that cadaver tissue is not as authentic as living tissue, meaning that dissection of cadavers is problematic. Cadaver tissue is highly different from the tissues of living human bodies, because the anatomical structures of cadavers are distorted. Indeed, there are significant differences in terms of quality, color and texture peculiarities between the tissues of cadavers and living human bodies. Another very important reason is that with the exception of surgical branches, the benefits of cadaveric dissection in anatomy lecture for the students in practice is controversial. This is because certain students (i.e., pharmacy, audiology, nursing, etc. branches) do not need knowledge of cadaver dissection. There are other disadvantages associated with cadaver usage in anatomy education, such as difficulties in cadaver procurement, transferal, preservation, high costs, short-term usability (since the tissues are dismantled and fragmented after the dissections), and psychological stress. All of these disadvantages have led to the debate about the effectiveness of cadaveric dissection in anatomy

education. Because of these reasons, particularly after the development of computer technology, alternative methods (including digital technologies) have been proposed for anatomy education. There are many computer systems that support anatomy education. Digital anatomical atlases with 2-dimensional materials and their multimedia versions are popular examples. On the other hand, virtual anatomy (VA) systems have become popular in recent years as they provide 3-D anatomical images and materials for the students. In anatomy education, VA allows anatomical structures to be seen from any point of view and VA is not limited in terms of the image angles. VA can present the morphology of anatomical structures as three-dimensional images, including their locations, and spatial relationships (e.g., its connections with other organs, its vascularization and its innervation) in the same scene. Thus, combined with specific learning tasks, interactive 3-dimensional (3D) visual materials have enormous potential to be used in place of traditional anatomy education methods (Brenton et al., 2007). Indeed, students stated that they found interactive systems such as VA to be valuable, and also noted significant progress in understanding the spatial relationships of organs (Preim & Saalfeld, 2018). In another study, students showed that 3D anatomy models were superior to 2D models. Again, in the same study, the major trend in anatomy education was shown to be towards 3D digital models (Azer & Azer, 2016).

4.1.7. Augmented reality (AR), virtual reality (VR), and wearable technologies in anatomy education

Although anatomy continues to be a core field in medical education, universities have increased the number of practical clinical course hours while reducing the hours assigned to theoretical courses in anatomy. With the introduction of Virtual Reality (VR) and Augmented Reality (AR) applications and devices, the anatomy subjects can be learned in an immersive manner through practice. Educational technologies such as AR or VR, allow the learner to interact with learning materials and interact better. The goal of AR and VR is to create a stronger environment that allows learners to more easily understand of complex concepts. Moreover, imitation ability of AR and VR allow students to acquire knowledge more deeply. Through observation and participation, the learners use and develop their own learning abilities (Moro et al., 2017). In 2009, the General Medical Council proposed various standards for the effective teaching of lessons for medical students. Among these proposals, medical schools also have to benefit from new technologies. Nowadays, we are able to use AR applications on both mobile and non-mobile devices. Indeed, in the learning process, AR applications are extremely useful in increasing student motivation (Ma et al., 2016).

There are two types of virtual environments that can be used in training with VR: a virtual world (e.g., a virtual room) that mimics the real world, or a computer-generated 3D object. Because users are often curious about learning in a virtual environment, they enjoy learning much more in a virtual world. This provides additional participation as well as motivation, the desire to exist in the virtual environment, interactive experiences, and ease of use (Moro et al., 2017). VR-based practices can help both patients and healthcare workers to better understand or develop new treatments for various medical conditions, as well as students. In the post-stroke treatment of adult patients, VR rehabilitation has proven to have innumerable benefits according to traditional treatment (Nicola et al., 2017). It can be said that the students spend more time learning anatomical structures with a 3D model. This is because students are more interested in exploring 3D models and have more interest in exploring anatomical structures when compared to the traditional 2D methods (Foo et al., 2013).

Cadaver dissection is often a part of anatomy teaching. However, the anatomical education in many disciplines of health sciences, such as sports medicine, dentistry, physiotherapy, nursing, audiology, pharmacy etc. do not benefit from the cadaver dissections. Today interactive 3D digital materials, particularly when they combined with specific learning tasks, have significant potency to be incorporated into, and even partly replace, these traditional methods. This is also due to the lack of cadaveric procurement and the limited time available for anatomy teaching or lack of teaching staff (Preim & Saalfeld, 2018). The emergence of new technologies such as mobile computing, AR and VR are leading to impressive innovations in the field of wearable technologies. Today, wearable technology have infiltrated into all sectors, from medicine, to entertainment, industry, to the gaming sector. In order to achieve the effective use of these new technologies, significant efforts must be made to integrate them into all fields of life. Because of the lack of available cadavers for anatomy education, students are directed to 3D digital anatomy materials that present better anatomical boundaries of organs. 3D models instead of traditional text books and 2D images give students better organ definition and conceptualization of the anatomical neighborhoods and spatial relationships of those organs (Estevez et al., 2010). Virtual reality simulation is achieved by integrating wearable technologies, so that students can quickly conceptualize complex 3D anatomical relationships (Fried et al., 2007). This technology can now be used in all areas of health science education and it can now be used for medical education, surgical education and even preoperative planning and patient education (Stepan et al., 2017).

4.2. Learning strategies that can enhance the effectiveness of anatomy education

4.2.1. Flipped learning in anatomy education

When both traditional face-to-face classroom education and e-learning education are conducted together, this mixed-learning environment can be defined as blended learning (Sloman, 2007). The Flipped Learning (FL or flipped classroom) model is actually a perfect blended learning model because its structure has both face-to-face and e-learning environments. Significant volumes of work have been published in the literature about FL, which has become increasingly popular in recent years. While there are many studies showing that the FL strategy provides learning gains, there are also studies that show that there is insufficient evidence about FL's significance and its long-term benefits (O'Flaherty & Phillips, 2015; Thai, de Weber & Valcke, 2017). Additionally, studies have also been conducted in relation to medical education, which suggests that, despite the positive perception of FL, there is less evidence on the effects of changes in knowledge and skills, and that there is no evidence of efficacy when a systematic review was conducted. However, in the same study, it was reported that in the FL group, when the students were given histology video lessons and quizzes before class activities, the students reported more effective learning in comparison with the traditional class (Chen et al., 2017). Morton and Colbert-Getz (2017) studied on the subject of teaching gross anatomy and they showed that FL have potential. The study was designed for first-year medical students and anatomy lessons. In this study, although there was greater success reported in terms of the questions requiring analysis in the experimental group (FL group), it was reported that there was no difference between the experimental group and the control group in terms of the overall performance.

Face-to-face learning can be minimized because of the large number of students in relation to the teaching staff. This can be achieved in crowded anatomy classes, through the support of Internet-based learning (Green & Whitburn, 2016). Consequently, the anatomy learning process can be successful. Indeed, when the instructor prefers to use teaching with the FL, then a blended learning environment will be achieved. In other words, it is a learning environment called "learning with blended pedagogies" (Oliver & Trigwell, 2005) and it integrates face-to-face learning with online-learning methods (Bliuc et al., 2007). When evaluated in this regard, it is clear that blended learning aims to create an efficient and productive media. By combining the best features of the face-to-face traditional learning model and the online learning model, it gives a valuable experience for students. (Green & Whitburn, 2016). In fact, with the e-learning environment used in mixed learning, more access is provided

to students in more than one place, thus providing more convenience and flexibility (Joynes & Fuller, 2016). Thus, it can be argued that FL, which is in the blended learning structure, has the potential to develop more interesting and meaningful learning experiences for the students.

4.2.2. Gamification in anatomy education

The use of game design elements to introduce out-of-game content to the learners is called gamification. Hamari et al. (2014) demonstrated that gamification is particularly effective in many fields, but especially in education. In the context of education and learning, studies have shown that gamification increases the participation, motivation and learning tasks in learning outcomes and makes the learning process more enjoyable. However, some negative aspects of gamification have also been emphasized in these studies that require attention, including increased competition, difficulties in task evaluation and design features. In other areas of education, successful gamification practices and gamification effectiveness in medical education can provide an innovative solution for students (Ahmed et al., 2015). In the last decade, some new game applications have been developed for education, such as Kahoot, Classcraft, Plickers, and Padlet, and the availability of mobile learning tools and their programs are important contributions of digital technology in the field of education.

Conclusion and recommendations

Today's students who have studied anatomy have grown up playing video games and using web-based applications. These applications are used extensively, and because of the specific features, it is natural for those students to expect fast and interactive feedback. The most important element used in the anatomy education is the cadaver, but problems are experienced due to procurement, sustainability problems due to lack of cadavers, high costs and other problems encountered during practice, which have encouraged the schools to benefit from modern digital technologies for anatomy education.

In particular, as a result of the increasing amount of new information produced in the field of medicine, anatomy course hours in curricula have been decreasing over the last several decades. Indeed, in all branches of health sciences, even though anatomy is considered the fundamental course, its teaching hours in class are decreasing due to the growing volume of information in other areas. This situation makes it inevitable that people will seek benefits from the advantages of the digital age technologies. For this reason, alternative learning and information sources such as MOOCs and infographics that can be used in anatomy training are mentioned in this study, and it is emphasized that more effective learning can be provided by

3D digital simulations, enhanced reality, virtual reality and other materials. In summary, it is mentioned that today's digital technologies can be integrated in anatomy education, not only for the face-to-face education model but the FL strategy, e-learning or online based environments can be introduced. Thus, these digital technologies contribute to the learning process. In conclusion, it is not inconceivable to see the integration of tools such as Web 4.0, artificial intelligence, which are still in their infancy, to these new applications and products of the digital age, which will enable the use of information, time and space more effectively in education. In the near future, new learning platforms that are more egalitarian, richer in content, and have more objective assessment facilities in education should be expected. Thus, it may become possible to effectively teach a lesson such as anatomy, which is term-intensive and application-oriented, without requiring the students to be physically present in the classroom. It is thought that this article can contribute to the anatomy lecturers or the health sciences teachers on improvement of learning environments and using digital technologies. It is also thought that this work will contribute to future studies on anatomy education using digital technologies.

For future studies, demonstrating the benefits of digital technologies on anatomy education will contribute to the development and widespread use of new learning environments. Studies upon the effectiveness of learning environment having one digital technology separately in anatomy education and studies upon effectiveness of learning environment having integrated of many digital technologies in anatomy education will create new possibilities and facilities for anatomy teachers. Therefore, it is recommended by researchers that the development of enriched learning environments through the use of digital technologies such as 3D digital anatomy materials and digital anatomy resources and even learning strategies based on digital technologies such as Flipped classroom, gamification etc. will provide crucial benefits to anatomy education.

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